STATE OF THE ARCTIC MARINE BIODIVERSITY REPORT UPDATE: MARINE MAMMALS

Technical Report

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CIRCUMPOLAR BIODIVERSITY MONITORING PROGRAM

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CAFF Conservation of Arctic Flora and Fauna

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Spotted seal. Photograph: Jay Verhoef/Alaska Fisheries Science Center, NOAA Fisheries Service

INTRODUCTION

Marine mammals are highly visible components of Arctic ecosystems that are important to the structure and function of these systems (Estes et al. 2016, Albouy et al. 2020). In addition, they are valuable resources for people living in the Arctic that also play a special role in the cultural identity of people in the North. Arctic marine mammals are all endemic to the Arctic region and hence a unique part of global biodiversity for which the Arctic range states have important stewardship responsibilities. In an ecosystem monitoring context, these large, mobile predators can serve as ecosystem sentinels, because they integrate changes at more cryptic levels of food webs, making them ideal monitoring subjects that have "added value" (Bossart 2006, Moore 2008, Sergio et al. 2008, Hays et al. 2019, Hazen et al. 2019, Stenson et al. 2020a).

CIRCUMPOLAR ARCTIC MARINE MAMMALS – SUMMARY OF STATUS UP TO AND INCLUDING SAMBR

Development of plans for circumpolar monitoring of Arctic marine mammals predate the formulation of the Circumpolar Biodiversity Monitoring Programme (CBMP) of the Arctic Council. The first concerted effort to organize circumpolar monitoring of a marine mammal species arose concomitantly with the formulation and signing of the International Polar Bear Agreement in 1973, in which all range states agreed to conduct research on polar bears and regularly share resulting scientific information to promote the species' survival. The polar bear remains the only Arctic species for which such a binding international agreement exists. However, progress has been made in planning circumpolar monitoring of other Arctic marine mammal species. A workshop sponsored by the US Fish and Wildlife Service and the US Marine Mammal Commission, held in Valencia (Spain), in 2007 brought together international Arctic marine mammal experts, specializing on ringed seals and white whales, to draft plans for monitoring these two species as "templates" for developing monitoring plans for all of the Arctic marine mammals. The workshop resulted in the publication of "A Framework for Monitoring Arctic Marine Mammals" (Simpkins et al. 2009) as well as a detailed plan for monitoring ringed seals (Kovacs 2014). A lot of the concepts developed in these early efforts fed into the CBMP Marine monitoring plan during its development phase, which identified five Arctic marine mammals as Focal Ecosystems Components (FECs), prioritized for circumpolar monitoring (Gill et al. 2011). The Arctic Biodiversity Assessment (Meltofte 2013) process as well as other Conservation of Arctic Flora and Fauna (CAFF) working group planning activities led to the expansion of the initial list of five species, to include all 11 Arctic endemic marine mammals as FECs in CAFF (CAFF 2017). This expansion was based on the fact that each Arctic marine mammal species occupies a separate niche, and all are endemic to the region and hence unique in a global biodiversity context. Additionally, the importance of these animals as resources and cultural values combined with the fact that they are facing serious conservation threats, largely associated with their tight affiliation with sea ice in a time of global warming, makes it essential that these animals (and their habitats) are monitored closely (e.g., Laidre et al. 2008, 2015, Kaschner et al. 2011, Kovacs et al. 2011, 2012).

Arctic marine mammals use sea ice of all types including glacier ice, multi-year ice, land-fast ice, and free-floating pack ice (often called drift ice) (Laidre et al. 2008, Kovacs et al 2011, Lydersen et al. 2014). Seasonally formed annual ice provides breeding habitat for pinnipeds, serving as an essential platform for birthing and pup rearing activities as well as providing a substrate for energy-efficient moulting. Most Arctic pinnipeds use sea ice (when it is available) throughout the year. Polar bears depend upon sea ice for travel and access to ice-associated seals. Polar bears den mainly on land but also on sea ice in the Southern Beaufort Sea although sea ice denning in this region has decreased concomitant with diminished sea ice (Fishbach et al. 2007, Durner et al. 2017). Sea ice provides a sheltered environment for whales and their calves, which is likely important protection against storms. Sea ice also provides protection from predators (killer whale (Orcinus orca)) and open-water feeding competitors, as well as providing important prey resources for marine mammals that live in the sympagic community. Of all ice types, loose seasonal pack ice is the most important as it serves as habitat (at least seasonally) for all 11 Arctic endemic marine mammal species (e.g., Laidre et al. 2008, 2015). Arctic marine mammals are all long-lived species with conservative life-history strategies. They have limited potential to respond rapidly to changing environmental conditions via adaptation and they also have limited potential for range shifting to track available sea ice, given their distributions in the High North coastal shelf seas and the low productivity conditions in the deep Arctic Basin to the north (Gilg et al. 2012). Thus, adjustment to habitat alteration is limited to behavioural, physiological, and morphological plasticity. Declines in sea ice are expected to have negative impacts on Arctic endemic marine mammals (e.g., Laidre et al. 2008, 2015, Kovacs et al. 2011, Post et al. 2013).

Hooded seal (male) in water. Photograph: Kit Kovacs and Christian Lydersen/Norwegian Polar Institute

CAFF's State of the Arctic Marine Biodiversity Report (SAMBR) was an update of the status of marine mammal populations presented in the Arctic Biodiversity Assessment (CAFF 2013) and in Laidre et al (2015), and it was the first comprehensive assessment of how Arctic marine mammals were being monitored. Major findings regarding marine mammals from SAMBR (CAFF 2017) included:

- Arctic marine ecosystems are rapidly changing due to atmospheric and oceanic warming causing impacts on sea ice and associated marine biota, including marine mammals.
- Various types of anthropogenic activity (oil and gas exploration and production, marine mining, commercial fisheries and both local and global shipping) are expected to increase along with sea ice losses, exacerbating the direct impacts of climate change on marine mammal populations.
- Marine mammals continue to be of great cultural and subsistence value to local peoples and have iconic species status at a global level.
- Considerable effort has gone into developing detailed monitoring plans for the ringed seal, beluga and polar bear, but these plans have not been implemented.
- Our level of knowledge remains inadequate to understand the impacts of climate and ecosystem change.
- Harvest levels are of concern for some marine mammal populations in the Arctic.
- Ongoing changes in the Artic are negatively impacting marine mammal health in some regions.
- We need to reach a level of knowledge such that we can practice forward-looking conservation that incorporates scientific evidence on species status with value-based conservation.

Specific recommendations in SAMBR for monitoring of marine mammals included:

- Communities in the Arctic should be integrally involved in the design and implementation of monitoring programs so that scientific knowledge and Traditional Knowledge (TK) holders can work collaboratively.
- Long-term data sets based on data from hunted animals provide an important information source, as they constitute base-line information on demographic parameters during different ecological regimes and thus they should be established or continued.
- Existing international monitoring plans such as those created for ringed seals and polar bear should be implemented (with adaptive management principles) to ensure appropriate monitoring of the eleven FECs (i.e., Arctic endemic marine mammal species).
- It is essential to obtain more knowledge about population sizes, densities, and trends as well as distributions of marine mammal populations to promoted conservation of stocks.
- Marine mammal monitoring efforts should be expanded to include parameters on health, passive acoustics, habitat changes and telemetry tracking studies.
- Marine mammal monitoring in the Arctic should be pursued in a multidisciplinary fashion with a high degree of collaboration across borders and between researchers, local communities, and Arctic governments to better understand complex spatial-temporal shifts in drivers, ecological changes, and marine mammal health.

Given the extreme variation in the rate and magnitude of large-scale alterations in the biophysical environment across the Arctic, as well as variable rates of change in human demography and activities, it was deemed by CAFF's marine mammal network that stock-by-stock assessments were required for SAMBR assessments. The circumpolar assessment of monitoring activities found a notable imbalance across the eight defined CAFF Arctic areas, with coverage assessed as ranging from moderate to non-existent. The Arctic Basin and large parts of the Russian Arctic had received little monitoring attention. Taxonomically, monitoring was also skewed, with polar bears, whales and walruses having somewhat better stock coverage with a greater number of (relatively) recent abundance estimates (post 2000) compared to the seals. However, coverage was incomplete for all taxonomic groups and the significant gaps made it impossible to provide a comprehensive assessment of the status of Arctic marine mammals. Trends were unknown for approximately 70% of the 84 Arctic marine mammal stocks recognized at the time of SAMBR, while the remaining 30% were evenly spread between increasing, decreasing or stable status. A significant number of stocks of ringed seals and bearded seal, as well as the few stocks of ribbon and spotted seals, had no abundance estimates and the majority of existing estimated were dated (some back to the 1970s); trends were not known for a single Arctic seal stock. Eighty-six per cent of stocks were harvested, while circa 13% were protected; one beluga stock, in Southwest Greenland, was declared extinct.

Walrus group, Spitsbergen, Norway. Photograph: Marta Kwiatkowska/Shutterstock.com

CIRCUMPOLAR ARCTIC MARINE MAMMALS – STATUS UPDATE SINCE SAMBR

Climate change has continued at an increasing rate since SAMBR with significant impacts on habitats important to Arctic marine mammals. A recent Intergovernmental Panel on Climate Change (IPCC) assessment concluded that: in recent years Arctic sea ice extent has continued to decline in all months of the year; shipping activities during the Arctic summer have increased over the past two decades concurrent with reductions in sea ice extent; Arctic sea ice has thinned, and thick (>5 year old) ice has declined by 90%; thinner ice enhances summer melt and makes the ice more vulnerable to fragmentation from Arctic cyclones and increased ocean swell conditions; regionally, summer ice loss is dominated by reductions in the East Siberian Sea and large declines in the Beaufort, Chukchi, Laptev and Kara Seas while winter ice loss is dominated by reductions within the Barents Sea; Arctic ice freeze-up is occurring later, delaying snowfall accumulation on sea ice; Arctic frontal positions are changing in the Eurasian and Atlantic Arctic; mixed layer temperatures in the ocean have increased at about 0.5ºC per decade over large sectors of the Arctic Basin that are now ice-free in summer; sea ice growth is being inhibited by increase Arctic Ocean albedo; polynyas will cease to exist where seasonal sea ice disappears or they will evolve to become part of the marginal sea ice zone due to changes in ice dynamics (i.e., the North Water polynya and the Circumpolar Flaw Lead) and that new or enlarged polynyas could result in regions where thinner ice becomes more effectively advected offshore, or where marine terminating glaciers increase land ice fluxes to the marine system; many Arctic glaciers are in a state of mass loss and tidewater glaciers frontal areas are shrinking with glacial melt and retraction (Meredith et al. 2019 and references therein).

Important biotic changes are also being noted in the communities in which marine mammals live. There is still some debate regarding climate change impacts on productivity levels in the Arctic but given the emerging view that open-water productivity is likely to increase in the Arctic with warmer temperatures and less sea ice cover (Bhatt et al. 2014, Arrigo and van Dijken 2015), available prey for marine mammals is still likely to be less spatially predictable and less lipid rich than the traditional prey species of Arctic marine mammals. This makes food both more energetically costly to acquire and of lower nutritional status. For example, key prey species such as polar cod (Boreogadus saida) are being negatively affected by a shortened ice season and reduced sea ice extent through loss of spawning habitat and shelter, increased predator pressure and reduced food availability (Christiansen 2017) and declines have been documented already in some areas (e.g., Brand and Fischer 2016, Skaret et al. 2018). Declining benthic biomass and a northward shift in benthic communities have been documented in several regions (Grebmeier 2012, Kortsch et al. 2015, Renaud et al. 2015, Grebmeier and Cooper 2016). Notable "borealization" of Arctic fish communities have taken place in the eastern Canadian Arctic and in the Barents Region, putting pressure on traditional Arctic fish stocks (Provencher et al. 2012, Fossheim et al. 2015). All of these physical and biotic changes in Arctic marine environments will impact marine mammal populations directly or indirectly, cumulatively with increasing human activity (shipping, tourism, exploration and industrial development, fishing etc) in areas that were previously sheltered by extensive sea ice coverage (e.g., Pizzolato et al. 2016, Dawson et al. 2018). These activities increase risks associated with accidents (and fuel spills), risk of species introductions, marine mammal ship strikes, potential marine mammal prey depletion and ocean noise (e.g., CCA 2016, Halliday et al. 2017, Hauser et al. 2017). Additionally, Arctic marine mammals are at greater risk as the climate warms as a result of increased exposure to, or toxicity of, contaminants (Sonne et al. 2017) and increasing disease risks (VanWormer et al. 2019). Yupik and Inupiaq subsistence hunters report changes in the distribution of a wide variety of marine mammals with declines in sea ice in recent decades and although marine mammal populations are thought to be healthy in their region, access is an increasing challenge because sea ice is less safe for travel, particularly for more southerly communities, making hunting more dangerous or impossible especially in spring (Huntington et al. 2017).. Northward expansions of summer ranges of a variety of temperate whales that feed in the Arctic have been documented on both the Pacific and Atlantic sides of the Arctic in recent years (e.g., Brower et al. 2017, Stafford et al. 2018a, Storrie et al. 2018); longer seasonal presence of these traditional summer visitors is likely to negatively impact available resources for Arctic species. A recent global assessment identified polar coastal waters as one of three geographic hotspots for levels of cumulative risk to marine mammals; Arctic marine mammals fell in the highest risk category when species diversity was incorporated into the spatial analyses (Avila et al. 2018).

Since SAMBR's publication, no new circumpolar monitoring programmes have been implemented for Arctic marine mammals. However, the Circumpolar Action Plan for polar bears has progressed with both 2-year and 10-year Action Plans that define monitoring objectives for the 19 stocks of polar bears worldwide; the plan is not binding to member states, but core parts of the monitoring have been adopted in some national programmes (Polar Bear Range States 2015). The Polar Bear Specialist Group of the IUCN (International Union for the Conservation of Nature) has also recently updated stock sizes and status (PBSG 2019a). Additionally, the North Atlantic Marine Mammal Commission (NAMMCO) and various scientific partners undertook a review of status and trends of the world's narwhal and beluga populations in 2017 – GROM (Global Review

Narwhal. Photograph: Jon Aars/Norwegian Polar Institute

of Monodontids), which is summarized in Hobbs et al. (2019). Walrus genetics studies in the Barents Sea Region suggest that northern and southern Barents Sea populations should be considered sufficiently different for management purposes, adding a new stock to this species assessment (Andersen et al. 2017). Additionally, although formal community-wide assessments have not taken place, the Arctic seals have been divided into more likely stocks/populations in this update, which align more closely with survey and management efforts. These factors have shifted the number of extant stocks from 83 at the time of SAMBR to 100 herein (see Table 1).

During the period from 2015-2020, abundance estimates have been undertaken for 14% of marine mammal stocks in the Arctic; some few regional sub-stocks have also received survey attention (Table 1). Additionally, information from 37 stocks have been published in this time period based on older surveys, or survey results have been revised to improve correction factors or other aspects of data treatment. Sometimes this changed the abundance estimate or its variance measurements. If the time scale is expanded to the last decade, approximately 30% of stocks have been surveyed; effort across taxonomic groups (whales, seals, walrus, and polar bears) is quite evenly spread in the period 2010-2020 (range 28%-31%). However, 14% of stocks for which there is some sort of estimate are >20 years old and an additional 16% of stocks have never been surveyed (mostly seals). Trends are unknown for 66% of marine mammal stocks overall (Figure 1). Within various groups of marine mammals, trends are known for circa 60% of whale stocks, 50% of polar bear stocks, 30% of walrus stocks and 10% of seal stocks (Figure 1).

The overall knowledge of the status of marine mammal stocks remains largely unchanged since SAMBR (see Table 2). Stocks of concern, that are known to be declining, include 3 polar bear stocks (1 more than at the time of SAMBR), one narwhal stock (new information), 2 beluga stocks that are continuing to decline; it is feared that these two beluga stocks (Canada-Ungava and Alaska-Kotzebue) may already be extinct (Hobbs et al. 2019). One hooded seal stock may be continuing to decline slowly (although it might now be stable at a new, low level). The number of stocks known to be in decline must also be viewed in the context of the fact that 66 stocks are of unknown status.

Table 1. Stock estimates for all marine mammal FECs. Sources in **bold** *report data collected prior to 2015 that have now been published or reassessed.* **Bold** *text for "Most recent survey year" and "Abundance" identify new data from surveys conducted (or reported) 2015-present. Harvest status is H=harvested; HQ= harvested according to a quota system; P = protected (not legally harvested).*

Stock	Species	CAFF Arctic Marine Area	Subpopulation (Region)	Most recent survey year	Abundance (variance)	Historically reduced	Current trend	Harvest status	Source
1	Beluga	Pacific Arctic	Eastern Chukchi Sea	2012	20,675 (CV 0.66)	Unknown	Unknown	H	**Lowry et al. 2017a**
2	Beluga	Beaufort	Eastern Beaufort Sea	1992	39.258	Unknown	Unknown	H	**Harwood et al. 1996, Allen and Angliss 2015**
3	Beluga	Pacific Arctic	Eastern Bering Sea	2000	6,994 (CI 3,162 - 15,472)	Unknown	Unknown	H	**Lowry et al. 2017b**
4	Beluga	Pacific Arctic	Bristol Bay	**2016**	**2,040 (CV 0.22)**	Not Reduced	Stable	H	Citta et al. 2019
5	Beluga	Hudson Complex	Western Hudson Bay	**2015**	**54,473 (CI 44,988-65,957)**	Not Reduced	Stable	H	Matthews et al. 2017
6	Beluga	Hudson Complex	James Bay	**2015**	**10,615 (CI 6,559-17,1785)**	Not Reduced	Unknown	H	Gosselin et al. 2017
7	Beluga	Hudson Complex	Eastern Hudson Bay	**2017**	**3,819 (CI 1,1664-8,765)**	Reduced	Stable	HQ	Gosselin et al. 2017
8	Beluga	Davis-Baffin	Ungava Bay	2008	32 (CI 0 – 94)	Reduced	near extinction	HQ	Doniol-Valcroze and Hammill 2012
9	Beluga	Davis-Baffin	Cumberland Sound	**2017**	**1,381 (CI 1,270-1,502)**	Reduced	Declining	HQ	DFO 2019
	Beluga	*Davis-Baffin*	*Greenland (Winter)*	*2012*	*9,072 (CI 4,895 - 16,815)*	*Reduced*	*Stable*	*HQ*	***Heide-Jørgensen et al. 2017a***
	Beluga	*Davis-Baffin*	*NOW Polynya (Winter)*	*2014*	*2,324 (CI 969-5,575)*	*Reduced*	*Unknown*	*HQ*	***Heide-Jørgensen et al. 2016***
10	Beluga	Arctic Archipelago	Eastern High Arctic- Baffin Bay	1996	21,200 (CV 0.25)	Reduced	Stable	H (Canada), HQ (Greenland)	Innes and Stewart 2002
11	Beluga	Atlantic Arctic	White Sea	2011	5,593 (CV 13%)	Unknown	Stable	HQ	Solovyev et al. 2012
12	Beluga	Atlantic Arctic	Svalbard	**2018**	**549 (CI 436-723)**	Reduced	Unknown	P	Vacquie-Garcia et al. 2020
13	Beluga	Kara -Laptev Seas	Barents - Kara and Laptev Seas		Unknown	Unknown	Unknown	HQ	
14	Beluga	Pacific Arctic	Gulf of Anadyr	**2017***	**3,000**	Unknown	Unknown	HQ	NAMMCO 2018a, Shpak 2019
x	Beluga	Atlantic Arctic	Southwest Greenland		0	**Extinct**			Hobbs et al. 2019
1	Narwhal	Arctic Archipelago, Davis-Baffin	Eclipse Sound	**2016**	**12,039 (CI 7,768-18,660)**	Unknown	Unknown	HQ	Marcoux et al. 2019
2	Narwhal	Arctic Archipelago, Davis-Baffin	Admiralty Inlet	2013	35,043 (CV 0.42)	Not Reduced	Stable	HQ	**Doniol-Valcroze et al. 2015a**
3	Narwhal	Arctic Archipelago, Davis-Baffin	Somerset Island	2013	49,758 (CV 0.20)	Not Reduced	Stable	HQ	**Doniol-Valcroze et al. 2015a**
4	Narwhal	Arctic Archipelago, Davis-Baffin	Jones Sound	2013	12,694 (CV 0.33)	Not Reduced	Unknown	HQ	**Doniol-Valcroze et al. 2015a**
5	Narwhal	Arctic Archipelago, Davis-Baffin	Smith Sound	2013	16,360 (CV 0.65)	Not Reduced	Unknown	HQ	**Doniol-Valcroze et al. 2015a**
6	Narwhal	Davis-Baffin	East Baffin Island fjords	2013	17,555 (CV 0.35)	Not Reduced	Stable	HQ	**Doniol-Valcroze et al. 2015a**
7	Narwhal	Hudson Complex	Northern Hudson Bay	2011	12,485 (CV 0.26)	Not Reduced	Stable	HQ	Asselin et al. 2012
8	Narwhal	Davis-Baffin	Inglefield Bredning, West Greenland	2007	8,368 (CI 5,209-13,442)	Reduced	Stable	HQ	Heide-Jørgensen et al. 2010

Stock	Species	CAFF Arctic Marine Area	Subpopulation (Region)	Most recent survey year	Abundance (variance)	Historically reduced	Current trend	Harvest status	Source
9	Narwhal	Davis-Baffin	Melville Bay, West Greenland	2014	3,091 (CI 1,228-7,783)	Reduced	Stable	HQ	**Hansen et al. 2015**
	Narwhal	Davis-Baffin	*West Greenland (winter aggregation)*	*2006*	*18,583 (CI 7,308-47,254)*	*Reduced*	*Stable*	*HQ*	***NAMMCO / JCNB 2015***
10	Narwhal	Atlantic Arctic	East Greenland			Reduced	Decreasing		
	Narwhal	*Atlantic Arctic*	*Scoresby Sund stock*	***2016***	***433 (CI 186-1,099)***	*Reduced*	*Decreasing*	*HQ*	*Hansen et al. 2019*
	Narwhal	*Atlantic Arctic*	*Kangerlussuaq stock*	***2016***	***269 (CI 137-550)***	*Reduced*	*Decreasing*	*HQ*	*Hansen et al. 2019*
	Narwhal	*Atlantic Arctic*	*Tasiilaq stock*	***2016***	******	*Reduced*	*Decreasing*	*HQ*	*Hansen et al. 2019*
11	Narwhal	Atlantic Arctic	NE Greenland		Unknown	Not Reduced	Unknown	p	
	Narwhal	*Atlantic Arctic*	*Dovebugt (summer) stock*	***2018***	***1,395 (CI 744-2,641)***	*Not Reduced*	*Unknown*	*P*	*Hansen et al. 2019*
12	*Narwhal*	*Atlantic Arctic*	*Svalbard (not Franz Josef Land)*	***2015***	***837 (CV 0.501)***	*Unknown*	*Unknown*	*P*	Vacquie-Garcia et al. 2017a
1	Bowhead	Pacific Arctic, Beaufort	Bering-Chukchi-Beaufort Seas	2011	16,820 (CI 15,176– 18,643)	Reduced	Increasing	HQ	Givens et al 2013, **2016**
2	Bowhead	Arctic Archipelago, Davis Baffin, Hudson Bay	East Canada-West Greenland	2013	6,446 (CV 26.4)	Reduced	Increasing	HQ	Doniol-Valcroze et al. 2015b
	Bowhead	*Davis Baffin*	*West Greenland winter component*	*2012*	*1,538 (CI 827 - 2,249)*	*Reduced*	*Stable*	*HQ*	*Rekdal et al. 2015*
3		Atlantic Arctic	NE Greenland-Svalbard-FJL			Reduced	Unknown	P	
	Bowhead	Atlantic Arctic	*Svalbard (partial range)*	***2015***	***343 (CV 0.488)***	*Reduced*	*Unknown*	*P*	Vacquie-Garcia et al. 2017a
	Bowhead	Atlantic Arctic	*NE Greenland summer component*	***2017***	***318 (CI 110-956)***	*Reduced*	*Unknown*	*P*	*Hansen et al. 2018b*
	Bowhead	*Atlantic Arctic*	*NEW polynya (winter)*	***2017***	***301 (CI 127-769)***	*Reduced*	*Unknown*	*P*	Boertmann et al. 2020
1	Ringed seal	Beaufort	Beaufort Sea	1976	40,000 (0.80 seal/km2)	Unknown	Unknown	H	Frost & Lowry 1981, 1984
2	Ringed seal	Pacific Arctic	Western Chukchi Sea	**2016**	**50,839 (CI 25,400-73,859)**	Unknown	Unknown	H	Chernook et al. 2019
3	Ringed seal	Pacific Arctic	Eastern Chukchi Sea	2000	200,857 (SE 25,502)	Unknown	Unknown	H	Bengtson et al. 2005
4	Ringed seal	Pacific Arctic	Eastern Bering Sea	2012	171,418 (CI 141,588-201,090)	Unknown	Unknown	H	Conn et al. 2014
5	Ringed seal	Pacific Arctic	Western Bering Sea (included waters outside the AMA)	2013	61,237 (CI 40,634-94,323)	Unknown	Unknown	HQ	**Chernook et al. 2018**
6	Ringed seal	Hudson Complex	Hudson and James Bays	1974	516,000 (0.73 - 2.97 seals/km2)	Unknown	Unknown	H	Smith 1975
			Southwestern Hudson Bay	*2008*	*33,701*	*Unknown*	*Likely decline*	*H*	*Chambellant et al. 2012*
7	Ringed seal	Davis-Baffin, Arctic Archipelago	Baffin Bay	1980s	1,200,000 (CF 0.57)	Unknown	Unknown	H	Kingsley 1998
8	Ringed seal	Atlantic Arctic	Greenland Sea & Southeast Greenland		Unknown	Unknown	Unknown	H	
9	Ringed seal	Atlantic Arctic	Barents Sea		Unknown	Unknown	Unknown	H	

Stock	Species	CAFF Arctic Marine Area	Subpopulation (Region)	Most recent survey year	Abundance (variance)	Historically reduced	Current trend	Harvest status	Source
10	Ringed seal	Atlantic Arctic	Svalbard	2003	7,585 (CI 6,332-9,085; minimal estimate)	Unknown	Unknown	H	Krafft et al. 2006
11	Ringed seal	Atlantic Arctic	White Sea	1990s	20,000 (minimal estimate)	Unknown	Unknown	HQ	Ognetov 2002
12	Ringed seal	Atlantic Arctic	Kara Sea	1994	150,000	Unknown	Unknown	HQ (Russia), H (Norway)	Ognetov 2002
13	Ringed seal	Atlantic Arctic	Laptev Sea		Unknown	Unknown	Unknown	HQ	
14	Ringed seal	Davis-Baffin	Labrador		Unknown	Unknown	Unknown	H	
15	Ringed seal	Arctic Basin	Arctic Basin		Unknown	Unknown	Unknown	P	
1	Bearded seal	Arctic Basin	Arctic Basin		Unknown (likely low or zero)	Unknown	Unknown		
2	Bearded seal	Beaufort	Eastern Beaufort Sea	1979	2,056 (SE 313)	Unknown	Unknown	H	Stirling et al. 1982
3	Bearded seal	Beaufort	Western Beaufort Sea		Unknown	Unknown	Unknown		
4	Bearded seal	Pacific Arctic	Eastern Bering Sea (included waters outside the AMA)	2012	301,836 (CI 238,195-371,147)	Unknown	Unknown	H	Conn et al. 2014
5	Bearded seal	Pacific Arctic	Western Bering Sea (included waters outside the AMA)	2013	35,373 (CI 25,837-49,654)	Unknown	Unknown	H	**Chernook et al. 2018**
6	Bearded seal	Pacific Arctic	Eastern Chukchi Sea	2000	27,000	Unknown	Unknown	H	Bengtson et al. 2005; Cameron et al. 2010
7	Bearded seal	Pacific Arctic	Western Chukchi Sea	**2016**	**14,590 (CI 6,404-24,560)**	Unknown	Unknown	HQ	Chernook et al. 2019
8	Bearded seal	Pacific Arctic	Eastern Siberian Sea		unknown	Unknown	Unknown	HQ	
9	Bearded seal	Atlantic Arctic	East Greenland		unknown	Unknown	Unknown	H	
10	Bearded seal	Atlantic Arctic	West Greenland		unknown	Unknown	Unknown	H	
11	Bearded seal	Arctic Archipelago, Davis-Baffin, Hudson Complexc	Arctic Archipelago, Davis-Baffin, Hudson Bay (Canadian waters)	1979	190,000	Unknown	Unknown	H	Cleator 1996
			Southwestern Hudson Bay	*2008*	*278*	*Unknown*	*Declining*		*Chambellant et al. 2012*
12	Bearded seal	Atlantic Arctic	Barents Sea			Unknown	Unknown	H	
13	Bearded seal	Atlantic Arctic	Svalbard		Unknown	Unknown	Unknown	H	
14	Bearded seal	Atlantic Arctic	White Sea		4,000-5,000	Unknown	Unknown	H	Svetochev & Svetocheva 2012
15	Bearded seal	Atlantic Arctic, Kara & Laptev	Pechora/Kara Sea (Laptev unknown)		40,0000	Unknown	Unknown	HQ	**Svetocheva et al. 2016**
1	Ribbon seal	Pacific Arctic	Eastern Bering Sea (included waters outside the AMA)	2007	184,697 (CI 139,617-240,225)	Unknown	Unknown	HQ (Russia)	Conn et al. 2014
2	Ribbon seal	Pacific Arctic	Western Bering Sea (included waters outside the AMA)	2013	14,535 (CI 9,429-22,872)	Unknown	Unknown	H	**Cheernook et al. 2018**

Stock	Species	CAFF Arctic Marine Area	Subpopulation (Region)	Most recent survey year	Abundance (variance)	Historically reduced	Current trend	Harvest status	Source
1	Harp seal	Davis-Baffin, Atlantic Arctic	Northwest Atlantic	2012	7,600,000 (CI 6,600,000-8,800,000)	Not Reduced	Increasing	H (Greenland), HQ (Canada)	**Hammill et al. 2020**
2	Harp seal	Atlantic Arctic	Greenland Sea	**2018**	**426,800 (CI 313,000-540,600)**	Not Reduced	Unknown	H (Greenland), HQ (Norway)	ICES 2019a
3	Harp seal	Atlantic Arctic	White Sea	**2018**	**1,497,000 (CI 1,293,000-1,701,000)**	Reduced	Stable	HQ (Norway) P (Russia)	ICES 2019a
1	Hooded seal	Davis-Baffin, Atlantic Arctic	Northwest Atlantic	2005	593,500 (CI 404,400-728,300)	Reduced	Increasing	H (Greenland), HQ (Canada)	Hammill and Stenson 2006
2	Hooded seal	Atlantic Arctic	Greenland Sea	**2018**	**76,623 (CI 58,299 – 94,947)**	Reduced	Decreasing	H (Greenland), P (Norway)	ICES 2019a
1	Spotted seal	Pacific Arctic	Eastern Bering Sea (included waters outside the AMA)	2012	461,625 (CI 388,732-560,348)	Unknown	Unknown	H	Conn et al. 2014
2	Spotted seal	Pacific Arctic	Western Bering Sea (included waters outside the AMA)	2013	22,424 (CI 13,185-39,207)	Unknown	Unknown	HQ	**Chernook et al. 2018**
1	Walrus	Pacific Arctic	Bering-Chukchi Seas	2006	~129,000 (CI 55,000–507,000)	Unknown	Unknown	HQ (Russia), H (USA)	Speckman et al. 2011
2	Walrus	Kara-Laptev	Laptev Sea	1992	3,000-5,000	Unknown	Unknown	P	Belikov and Boltunov 2005
3	Walrus	Hudson Complex	North and Central Foxe Basin	2011	14,093 (SE 6.704)	Not Reduced	Stable	HQ	Stewart et al. 2013, **Hammill et al. 2016a**
4	Walrus	Hudson Complex	South and East Hudson Bay	2014	200 (CI 70-570)	Unknown	Unknown	HQ	**Hammill et al. 2016b**
5	Walrus	Hudson Complex, Davis-Baffin	North Hudson Bay-Hudson Strait-Southeast Baffin Island-North Labrador		Unknown	Unknown	Unknown	H (Canada) or HQ (Greenland)	
6	Walrus	Davis-Baffin	Southeast Baffin Island (summer aggregation)	2007	2,500 (CI 1,800-3,500)	Unknown	Unknown	H	Stewart et al. 2014a
7	Walrus	Hudson Complex	North Hudson Bay summer aggregation (not including Baffin Bay)	2014	7,100 (2,500-20,400)	Unknown	Unknown	H	**Hammill et al. 2016b**
	Walrus	*Hudson Complex*	*Hudson Strait winter aggregation*	*2012*	*6,020 (CI 2,485-14,585)*	*Unknown*	*Unknown*	*H*	*Elliott et al. 2013*
	Walrus	*Davis-Baffin*	*West Greenland winter aggregation*	*2012*	*1,408 (CI 922-2,150)*	*Reduced*	*Increasing*	*HQ*	*Heide-Jørgensen et al. 2014*
8	Walrus	Arctic Archipelago	West Jones Sound	2008	503 (CI 473-534)	Not Reduced	Stable	HQ	Stewart et al. 2014b
9	Walrus	Arctic Archipelago	Penny Strait/ Lancaster Sound	2009	727 (CI 623-831)	Not Reduced	Stable	H	Stewart et al. 2014b
	Walrus	Davis-Baffin	*Winter (Greenland)*	*2014*	*2,544 (CI 1,513-4,279)*	*Reduced*	*Increasing*	*HQ*	*Heide-Jørgensen et al. 2016*
10	Walrus	Davis-Baffin	Summer (Canada)	2009	1,251 (CL 571-2,477)	Reduced	Increasing	HQ	Stewart et al. 2014c
11	Walrus	Atlantic Arctic	East Greenland (summer)	**2017**	**279 (CI 226-345)**	Unknown	Decreasing	HQ	NAMMCO 2018b

Stock	Species	CAFF Arctic Marine Area	Subpopulation (Region)	Most recent survey year	Abundance (variance)	Historically reduced	Current trend	Harvest status	Source
12	Walrus	Atlantic Arctic	Northern Barents Sea		Unknown	Reduced	unknown	P	
	Walrus	Atlantic Arctic	*Svalbard (not including FJL)*	***2018***	***5,503 (CI 5031-6036)***	***Unknown***	***Increasing***	***P***	*MOSJ 2019*
13	Walrus	Atlantic Arctic	Southern Barents Sea		Unknown	Unknown	Unknown	P	
	Walrus	*Atlantic Arctic*	*Pechora Sea*	*2010*	*3,943 (CI 3,605-4,325)*	*Unknown*	*Unknown*	*P*	*Lydersen et al. 2012*
			Kara Sea-Novaya Zemlya	*2013*	*1,355 (direct count/minimum estimate)*	*Unknown*	*Unknown*	*P*	***Semyonova et al. 2015***
1	Polar bear**	Arctic Basin	Arctic Basin	-	Unknown	Unknown	**Unknown**	P	PBSG 2019a
2	Polar bear	Davis-Baffin	Baffin Bay	2013	2,826 (CI 2,059-3,593)	Not Reduced	**Unknown**	HQ	**SWG 2016**
3	Polar bear	Atlantic Arctic	Barents Sea	2004	2,644 (CI 1,899-3,592)	Unknown	**Stable**	P	Aars et al. 2009
4	Polar bear	Pacific Arctic	Chukchi Sea	**2016**	**2,937 (CI 1,552-5,944)**	Unknown	**Stable**	H	Regehr et al. 2018
5	Polar bear	Davis-Baffin	Davis Strait	2007	2,158 (CI 1,833-2,542)	Not Reduced	**Stable**	HQ	Peacock et al. 2013
6	Polar bear	Atlantic Arctic	East Greenland	-	Unknown	Unknown	**Unknown**	HQ	PBSG 2019a
7	Polar bear	Hudson Complex	Foxe Basin	2010	2,585 (CI 2,096-3,189)	Not reduced	**Stable**	HQ	**Stapleton et al. 2016**
8	Polar bear	Arctic Archipelago	Gulf of Boothia	2000	1,592 (CI 870-2,314)	Unknown	**Stable**	HQ	Taylor et al. 2009
9	Polar bear	Davis-Baffin	Kane Basin	2014	357 (CI 221-493)	Not Reduced	**Increasing**	HQ	**SWG 2016**
10	Polar bear	Kara and Laptev Seas	Kara Sea	-	Unknown	Unknown	**Unknown**	P	
11	Polar bear	Arctic Archipelago	Lancaster Sound	1997	2,541 (CI 1,759-3,323)	Unknown	**Unknown**	HQ	Taylor et al. 2008
12	Polar bear	Kara - Laptevc	Laptev Sea			Unknown	**Unknown**	P	PBSG 2019a
13	Polar bear	Arctic Archipelago	M'Clintock Channel	2000	284 (CI 166-402)	Unknown	**Increasing**	HQ	Taylor et al. 2006
14	Polar bear	Beaufort,- Arctic Archipelago, Arctic Basin	Northern Beaufort Sea	2006	980 (CI 825-1,135)	Not reduced	**Unknown**	HQ	Stirling et al. 2011
15	Polar bear	Arctic Archipelago	Norwegian Bay	1997	203 (CI 115-291)	Unknown	**Unknown**	HQ	Taylor et al. 2008
16	Polar bear	Beaufort	Southern Beaufort Sea	2010	907 (CI 548-1,270)	Reduced	**Declining**	HQ (Canada), H (USA)	**Bromaghin et al. 2015**
17	Polar bear	Hudson Complex	Southern Hudson Bay	**2016**	**780 (CI 590-1,029)**	Reduced	**Declining**	HQ	Obbard et al. 2018
18	Polar bear	Arctic Archipelago	Viscount Melville	1992	161 (CI 121-201)	Unknown	**Unknown**	HQ	Taylor et al. 2002
19	Polar bear	Hudson Complex	Western Hudson Bay	**2016**	**842 (CI 562-1,121)**	Reduced	**Declining**	HQ	Dyck et al. 2017

* Expert assessment in the Global Review of Monodontid stocks (NAMMCO 2018a)
**Trend assessments for polar bears PBSG 2019a, and adjustments in PBSG 2019b
***The most recent survey in this area did not encounter any animals, so an abundance estimate could not be calculated

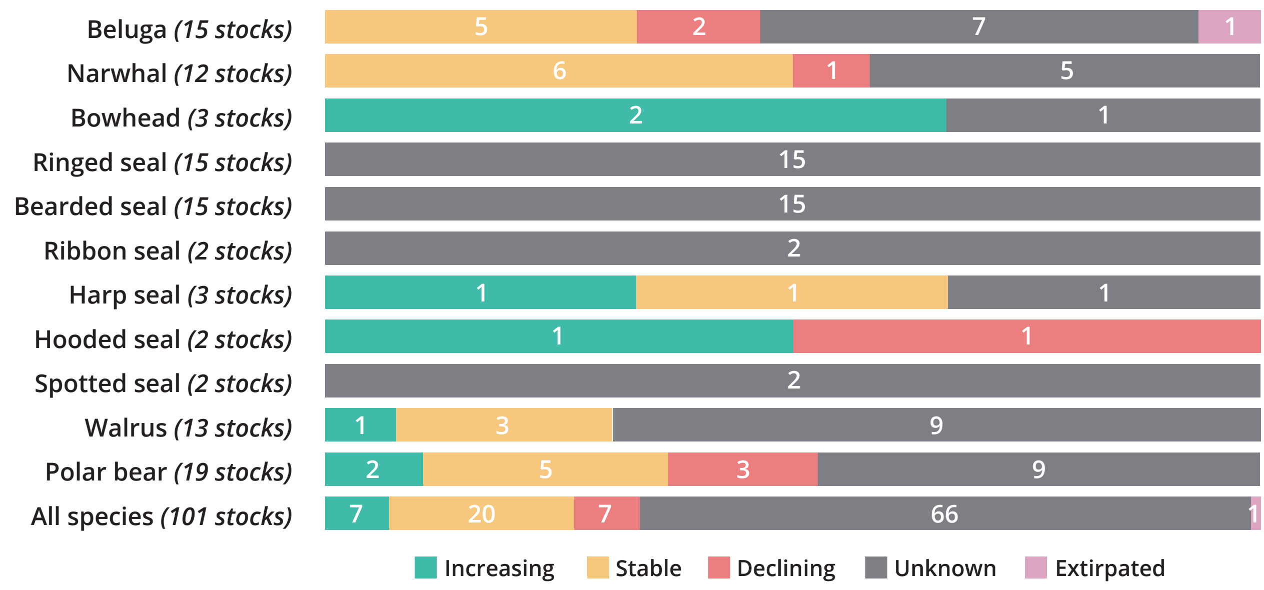


Figure 1. Marine mammal FEC trends 2020

Table 2. Trend status of extant marine mammal stocks in 2020 compared to SAMBR (blue highlights).

Species	No stocks/ regional groups	Status unknown	Increasing	Decreasing	Stable
Beluga	14	7 (50%)	-	2 (14%)	5 (36%)
	16	11 (73%)	1 (7%)	2 (12%)	1 (7%)
Narwhal	12	5 (42%)	-	1 (8%)	6 (50%)
	11	6 (55%)	-	-	5 (45%)
Bowhead	3	1 (33%)	2 (66%)	-	-
	3	1 (33%)	2 (66%)	-	-
Arctic whales	2020	**45%**	**7%**	**10%**	**39%**
Arctic whales	SAMBR	**62%**	**10%**	**7%**	**21%**
Ringed seal	15	15 (100%)	-	-	-
	9	9 (100%)	-	-	-
Bearded seal	15	15 (100%)	-	-	-
	8	8 (100%)	-	-	-
Ribbon seal	2	2 (100%)	-	-	-
	1	1 (100%)	-	-	-
Harp seal	3	1 (33%)	1 (33%)	-	1 (33%)
	3	-	1 (33%)	-	2 (66%)
Hooded seal	2	-	1 (50%)	1 (50%)	-
	2	-	1 (50%)	1 (50%)	-
Spotted seal	2	2 (100%)	-	-	-
	2	2 (100%)	-	-	-
Arctic seals	2020	**90%**	**5%**	**3%**	**3%**
Arctic seals	SAMBR	**79%**	**8%**	**4%**	**8%**
Walrus	13	9 (69%)	1 (8%)	-	3 (23%)
	11	6 (55%)	1 (9%)	-	4 (36%)
Polar bear	19	9 (47%)	2 (11%)	3 (16%)	5 (26%)
	19	12 (63%)	1 (5%)	1 (5%)	5 (26%)
Total 2020	**100**	**66%**	**7%**	**7%**	**20%**
Total SAMBR	**83**	**65%**	**8%**	**6%**	**20%**

FEC UPDATES

The status of the 11-marine mammal FECs are presented individually below, along with a brief assessment of climate change impacts to date, in addition to other threats.

1. Polar bear *Ursus maritimus*

The IUCN/Polar Bear Specialist Group (PBSG) published a status update for the world's 19 polar bear subpopulations in the fall of 2019 (PBSG 2019a), the first complete assessment since SAMBR was finalized. New criteria for status and trend assessments were developed and these were implemented for the first time in the 2019 update. Data deficiency remains a problem for trend assessments for some polar bears; there are enough data to assess short term trends for 10 of 19 subpopulations, and long-term trends for eight of 19 subpopulations. Five subpopulations have a stable (or likely stable) short term trend, two are likely or very likely increasing, and three are likely decreasing over the last few decades. New population estimates are available for three subpopulations since SAMBR: the Chukchi Sea (Likely stable; Regehr et al. 2018), Southern Hudson Bay (Likely declining; Obbard et al. 2018) and Western Hudson Bay (Likely declining; Dyck et al. 2017). Additionally, Norwegian Territories in the Barents Sea have been surveyed (Aars et al. 2017), the results of which suggest that this population is likely stable or increasing, but conclusions cannot be made without surveying areas around Franz Josef Land. There is an unresolved boundary issue between the Northern and Southern Beaufort Sea subpopulations; a new boundary has been used by management authorities in the Northwest Territories and the Yukon Territory. The PBSG has adopted interim use of the revised boundary change until new analyses have been carried out.

Sea ice losses induced by global warming are a serious concern for polar bears (Stern and Laidre 2016), although there is currently considerable variation in climatic conditions and therefore sea ice prevalence across the polar bear's circumpolar range (PBSG 2019a). Optimal sea ice habitat conditions for polar bears have declined dramatically in the eastern Beaufort Sea, Fox Basin, Baffin Bay, the Barents Sea and other locales (Sahanatien and Derocher 2012, McCall et al. 2016, Stern and Laidre 2016, Lone et al. 2018a). Some populations have responded to these altered conditions by showing range contractions (Laidre et al. 2020a), while others have shown range expansion (Durner et al. 2019, Laidre et al 2020b). Not surprisingly, changes in the timing, distribution and thickness of sea ice and snow have been linked to phenological shifts, and changes in distribution and denning locations, foraging behaviour and survival rates of polar bears (e.g., Derocher et al. 2011, Andersen et al. 2012, Hamilton et al. 2017, Escajeda et al. 2018). For example, Chukchi Sea polar bears have increased land use during the summer, primarily on Wrangel Island and the Chukotka Peninsula in Russia (Rode et al. 2015).

Polar bear on melting ice floe, Arctic Ocean. Photograph: FloridaStock/Shutterstock.com

Similarly, in Svalbard polar bears are spending more time on shore in summer, decoupling the traditional, tight, ringed seal-polar bear predator-prey system; bears are targeting land-nesting birds, with devastating consequences for duck and goose colonies (Prop et al. 2015, Hamilton et al. 2017). Olsen et al. (2017) document a trend toward less denning on sea ice and more denning on land in the southern Beaufort Sea polar bear population. Rode et al. (2018a, b) found that this southern Beaufort population was fasting longer and had poorer body condition in recent years. In the new land-based denning areas they are using, high snow depths were important determinants of breeding success. Wilson et al. (2014, 2016) found that habitat selection preferences of polar bears on the sea ice in the Chukchi Sea have not changed over time despite declines in the availability of their preferred habitats. In this region bears seem to have maintained normal body condition and have not experienced increasing lengths of the fasting period; den emergence is later than in the Beaufort Sea as well (Rode et al. 2018a,b). McCall et al. (2016) report declines in body condition, survival and abundance for polar bears in Hudson Bay (at the southern end of the polar bears' distribution), concomitant with sea ice declines (also see Obbard et al. 2016). Less ice is also driving polar bears to travel over greater distances and swim more than previously both in offshore and in coastal areas, which can be particularly dangerous for young cubs (Durner et al. 2017, Pilfold et al. 2017, Lone et al. 2018a,b). Cumulatively, changes in sea ice patterns are driving demographic changes in polar bears, including declines in some populations (Lunn et al. 2016, McCall et al. 2016). Shifts toward stable or increasing numbers are in some populations due to implementation of protective management measures (i.e., reduced harvest quotas), while in other populations newly available food sources, such as whale carrion, are becoming available to polar bears (Galicia et al. 2016, Stapleton et al. 2016).

A new study, utilizing data linking ice availability to demographic performance of polar bears modelled the projected future status of 13 polar bear subpopulations and found that declining reproduction and adult survival is likely to lead to extirpation of some subpopulations within this century, the actual proportion depending on the level of reduction of greenhouse emissions achieved.

2. Bowhead whale *Balaena mysticetus*

Three of four recognized bowhead whale stocks occur in the CAFF region. Since the data compilation undertaken for SAMBR, abundance estimates have been reworked for two of these stocks (Doniol-Valcroze et al. 2015b, Givens et al. 2016) and survey effort has taken place covering at least part of the range of the third population. Additionally, a novel method has been undertaken by Frasier et al. (2020) using genetic mark-recapture tools to explore trends in numbers of bowhead whales in Eastern Canada–West Greenland; this method suggested 11,747 (CI 8,169-20,043) bowhead whales vs the more conventional method's assessment of 6,446 (CV 26.4) for this same area. Whichever method is used, the Bering-Chukchi-Beaufort and the stock (or stocks) in Eastern Canada-West Greenland populations are thought to be approaching pre-commercial whaling numbers. The third stock, which is most poorly documented, has had considerable survey effort since SAMBR. For the first time surveys have been undertaken in Northeast Greenland during both summer and winter (Hansen et al. 2018b, Boertman et al. 2020) and a large fraction of the drift ice north of Svalbard (starting at the Russian border and working westward to the west side of Svalbard) has also been surveyed using ships and helicopters (Vacquié-Garcia et al. 2017a). Intensive and highly diverse singing during winter months recorded in the north-western Fram Strait suggests that this area is a mating ground for this small stock of bowhead whales (Ahonen et al. 2017, Stafford et al. 2018b). Recent tagging studies conducted on animals in this population indicate that this population disperses over a large area that encompasses ice-filled waters between East Greenland (the Northeast Water) all the way over to Franz Josef Land (Kovacs et al. 2020a). But Russian areas, which are home to part of this stock, have not yet been surveyed (Gavrilo 2015). This wide-ranging stock remains Endangered, though it is more numerous than previously thought; it likely numbers in the low hundreds (Cooke and Reeves 2018).

Sea ice reductions have occurred in recent decades throughout the bowhead whale's range. But, unlike many of the other ice-affiliated marine mammals, bowhead whales are showing some positive responses to reduced sea ice cover in some regions. For example, the recent 'new normal' conditions in the Pacific Arctic seemingly provide bowhead whales with optimal foraging opportunities, both from increased upwelling of copepod prey in the Beaufort Sea and robust advection of copepod and euphausiids prey through the Bering Strait into the Chukchi and western Beaufort Sea (Moore 2016), resulting in improved body condition of bowhead whales in recent years in the Beaufort Sea area (George et al. 2017). Sampling along baleen plates suggests that bowhead whales are displaying some flexibility in diet concomitant with changes occurring in lower trophic levels (Pomerleau et al. 2018, Fortune et al. 2020), and also that migratory shifts track temporal shifts in sea ice concentrations (de Hart and Picco 2015). Some tracking studies also suggest that bowheads are now foraging in areas where they can target prey other than calanoid copepods (Harwood et al. 2017), although Citta et al. (2015) have shown that core areas for the Bering-Chukchi-Beaufort population are still tightly tied to oceanographic conditions favouring their traditional Arctic copepod prey. Telemetry studies have

Bowhead whale at ice edge.Photograph: Kit Kovacs-Christian Lydersen/Norwegian Polar Institute

been conducted on all bowhead whale stocks in CAFF Arctic areas recently (Quakenbush et al. 2018, Kovacs et al. 2020a, Matthews et al. 2020, Teilmann et al. 2020), which illustrate modestly differing ecologies among populations in terms of migration patterns. Changes in distribution have occurred in the Beaufort Sea with the whales shifting their overall distribution westward. They are also coming into shallow coastal waters earlier in the season and in greater numbers than in the past (Clarke et al. 2018, Druckenmiller et al. 2018). Another positive observation has been that persistent organic pollutant concentrations (POPs) have declined markedly in bowhead whales in Alaska over the past few decades (Bolton et al. 2020). However, recent habitat studies in West Greenland have documented that bowhead whale movements away from Disko Bay largely followed sea surface temperature patterns, specifically targeting a very narrow range of temperatures, between -0.5 to 2°C (Chambault et al. 2018). Similarly, habitat assessment of the Spitsbergen population suggest that they show a strong preference for cold, ice-filled waters (Kovacs et al. 2020a). If they are tied to such a narrow range of cold water to thrive, they will be quite vulnerable to the warming conditions in the Arctic. Increasing killer whale predation has already been documented for some stocks (George et al. 2017, Matthews et al. 2020) and increasing anthropogenic noise is a conservation concern for this highly vocal species that communicates over large distances (Blackwell et al. 2015, Halliday et al. 2018).

3. Narwhal *Monodon monoceros*

Narwhals are present in all CBMP Arctic Marine Areas, except for the Beaufort and Pacific Arctic. Since the SAMBR report, there are new abundance estimates available for narwhals in Eclipse Sound in the Baffin Bay – Davis Strait area (Marcoux et al. 2019), north of Svalbard in the Arctic Basin/Atlantic Arctic boundary region (Vacquié-Garcia et al. 2017a), and five regions of East Greenland: Greenland Sea (winter and summer), Dovebugt, Scoresby Sound, Kangerlussuaq and Tasiilaq (Hansen et al. 2019).

In Canada and most of Greenland, satellite telemetry studies have shown that narwhals have a moderate degree of site fidelity and return to the same summering and wintering areas almost every year, spending summer in bays and fjords with glacier fronts and winters in deep offshore waters with dense sea ice cover (e.g.: Heide-Jørgensen et al. 2015). Recently, it has been discovered, using aerial surveys (Vacquié-Garcia et al. 2017a) and passive acoustic monitoring (Ahonen et al. 2019, Ugarte 2020), that narwhals in the Barents Sea, Fram Strait and parts of the Greenland Sea have a different seasonal distribution pattern, remaining in offshore ice-covered waters year-round, favouring areas with up to 90% ice coverage. A telemetry study using temperature/depth/salinity loggers and hydrophones mounted on free ranging narwhals in East Greenland showed that narwhals tend to feed at depths of 300-850 m and temperatures of 0.6 – 1.5°C, targeting waters that are colder than the average available to them (Heide-Jørgensen et al. 2020). Other recent studies show that narwhal densities during summer are highest in the coldest parts of their distribution (Chambault et al. 2020). A phylogeographic and demographic study of historical conditions for narwhal suggested that suitable habitat and population size of narwhals declined during the last ice age and subsequently expanded greatly during the last 15,000 years (Louis et al. 2020). Louis et al. (2020) also predicted that narwhal habitat will be reduced again in the coming decades due to sea ice losses and increased water temperatures arising from global warming.

Other challenges for narwhals associated with a reduction of sea ice include increased predation by killer whales, which has already been observed in Arctic Canada (Breed et al. 2017, Lefort et al. 2020) and disturbance from increased vessel traffic. There are large and expanding mining activities in Baffin Island (https://www.baffinland.com/expansion-project/) and developments planned for Northern Greenland (https://govmin.gl/2020/06/dundas-titaniums-application-for-exploitation-sia-and-eia-in-public-consultation/ & https://en.wikipedia.org/wiki/Citronen_mine). The Baffinland project in particular has the potential to negatively impact the narwhals in Eclipse Sound, and the Baffin Bay – Davis Strait wintering grounds, as it has greatly increased shipping in the area, and includes use of ice breakers during the spring and autumn. However, the largest threat to narwhals today is unsustainable subsistence hunting in the small populations of Melville Bay and East Greenland. In Melville Bay, the number of narwhals killed by hunters has likely been unsustainable for a decade or more (Heide-Jørgensen et al. 2020). From 2007 to 2019, the size of the area used by narwhals in Melville Bay has shrunk by 84% from 16,000 to 2600 km2 (Hansen et al. 2020). The North Atlantic Marine Mammal Commission (NAMMCO) and the Canada-Greenland Joint Commission on Conservation and Management of Narwhal and Beluga (JCNB) recommended a limit of 280 removals between 2015 and 2019 (NAMMCO/JCNB 2015), but the estimated accumulated removal during this period was at least 423 narwhals (Government of Greenland 2020). Narwhals in East Greenland were recently evaluated by NAMMCO's Scientific Committee who recommend total protection of the animals in the three small stocks south of the East Greenland National Park, that number in the few hundreds, to avoid extirpation by hunting (NAMMCO 2019). The Greenlandic association of fishers and hunters (KNAPK) does not agree with this assessment and the Government of Greenland, which takes both scientific advice and resource user's knowledge into consideration when taking management decisions, has proposed a gradual reduction of quotas in East Greenland from 66 in 2019 to 20 by 2023 (APNN 2019). Modelling conducted by the NAMMCO Scientific Committee concluded that even this level of catch will result in the extinction of narwhals south of the East Greenland National Park (NAMMCO 2019).

Beluga. Photograph: Laura Morse/Alaska Fisheries Science Center/NOAA Fisheries Service

4. Beluga whale (white whale) *Delphinapterus leucas*

Beluga whales are found throughout the circumpolar Arctic, and this species also extends into subarctic waters in some regions. They likely number > 200,000 animals world-wide, across the twenty-one beluga stocks recognized globally (Hobbs et al. 2019). The Southwest Greenland stock is thought to have gone extinct in the 1920s due to overharvesting (Hobbs et al. 2019). Fourteen remaining (extant) stocks occur within CAFF boundaries. The trend status of the majority of Arctic stocks (8 of 14) is unknown. Three extant stocks in the Arctic warrant particularly high conservation concern: 1) the Ungava Bay stock was thought to number only in the tens during the last survey in 2008, and although it has not been surveyed since, it clearly borders on extinction (Doniol-Volcroze and Hammill 2012); 2) a recent aerial survey of the Svalbard stock (549 (95% CI: 436–723)) confirmed the suspected near extirpation of this now small population due to commercial overharvesting that took place in the 1950s and 1960s (Vacquiè-Garcia et al. 2020); the linkage of this population with belugas in Franz Josef Land (or elsewhere in the Barents Sea region) is currently unknown; 3) the Cumberland Sound population numbers approximately 1,400 currently but is in decline (Watt et al. 2020). The estimated population growth rate cannot compensate for harvests of 41 landed animals annually, plus an estimated 15 animals struck and lost. Watt et al. (2020) concluded that the current harvest in Pangnirtung is not sustainable, those these authors also note that other factors may also be impacting the dynamics of this population. The relatively small stocks in Eastern Hudson Bay and the belugas in the Kara-Laptev (Barents Sea) Seas also warrant conservation concern because these beluga populations live in areas with significant levels of industrialization, with rapidly increasing levels of shipping concomitant with rapid environmental change. Five of the Arctic stocks are large (> 10,000 individuals) and considered secure (see Table 1).

Although belugas do manage to survive in areas with seasonally ice-free waters, they are highly ice adapted and similar to the other Arctic endemic marine mammals are likely to be challenged by global warming. The physical changes taking place in the Arctic, with warmer water and air temperatures and concomitant sea ice losses will affect prey distribution and availability and bring new species, including predators and novel pathogens into contact with belugas (Kovacs et al. 2011, Norman et al. 2015). Choy et al. (2017) found declines in individual growth rates in eastern Beaufort Sea beluga whales over the past 20 years that were attributed to changing environmental conditions. These authors also note that traditional hunters are finding it challenging to access belugas because of decreased predictability in weather and sea ice conditions. Brown et al. (2017) report that beluga diets in Cumberland Sound show decreasing influence from sympagic food sources and more pelagic prey, signals concomitant with declines in sea ice. Changes in beluga habitat use have been clearly documented around Svalbard, with the whales broadening their use of open fjord areas in recent years, though glacier fronts still appear to be key foraging habitats for this population (Hamilton et al. 2019a). In areas near human populations pathogen introductions are a particular concern for beluga, particularly in light of the potential for them to become more virulent with warming water (VanWormer et al. 2019). Reduced seasonal ice cover brings increased shipping, vessel traffic, icebreaking, and noise disturbance along shipping routes, such as the Northern Sea Route. In restricted areas, belugas face the potential for significant displacement from important habitat as they attempt to avoid ships and ship strikes (Reeves et al. 2014). The noise of icebreaking has led to some observed shifts in distribution and such noise has the potential to disrupt communication and normal foraging and navigation (Erbe and Farmer 1998, 2000). Oil, gas, and mining activities and associated seismic surveys also bring noise pollution and various forms of construction disturbance into the belugas' favoured near-shore habitats. The potential for oil spills is also an increasing concern. In Canada, hydroelectric development and modification of estuarine environments have had impacts the temperature, salinity, and other habitat features belugas rely on for many aspects of their life history. Interactions with fisheries are not considered a serious threat to belugas currently, but this may change as fishing activity increasingly moves north. The impacts that organic contaminants and heavy metals can have on belugas has been well documented in the past for St. Lawrence Estuary (Lebeuf et al. 2014, Simond et al. 2017) at the southern reaches of the belugas' distribution, but pollution is also already an issue for the species in the Arctic as well with Svalbard belugas having very high contaminant burdens that are thought to be impacting immune function (e.g., Villanger et al. 2020). Several beluga stocks are already facing the impacts of sea ice losses and industrial development simultaneously, leading to a need for research on the cumulative effects of multiple stressors on populations of concern. Natal philopatry, their fidelity to traditional migratory routes and feeding areas and their complex social structure are thought to increase the vulnerability of belugas to overharvesting and other threats that reduce the quality or quantity of suitable habitat (Caron and Smith 1990, Colbeck et al. 2013, O'Corry-Crowe et al. 2018, 2020).

5. Walrus *Odobenus rosmarus*

Walrus have a discontinuous circumpolar Arctic distribution, occupying six of the eight CBMP Arctic Marine Areas. Both walrus subspecies were commercially overharvested in the past (e.g., Fay 1979, Lønø 1970) but most walrus stocks are thought to be recovering following complete protection or the introduction of quota-based harvesting (e.g., Kovacs 2016). Walruses occupy a large range but have a narrow ecological niche, requiring large areas of shallow water with bottom substrates that support a productive bivalve community and the reliable presence of open water over feeding areas, as well as suitable ice or land nearby for haul out (e.g., Kovacs 2016, COSEWIC 2017). Since SAMBR, new information on genetics, movements, distribution and abundance, contamination, ecology, and harvest data has become available for the Alaskan, Canadian, Greenlandic, Barents. Laptev, Chukchi, and Pechora Sea populations, although large knowledge gaps remain, in particular in terms of population trends.

Walrus adults protecting calf, Svalbard. Photograph: Andries Combrinck/Shutterstock.com

Satellite tagging studies have shown that the walrus population that winters along the north western coast of Greenland ranges into Canadian waters more than previously realized (Heide-Jørgensen et al 2017b). Thus, Canadian catches from four communities are included in the Greenland catches for assessment purposes (NAMMCO 2018). Walrus genetics studies in the Barents Sea Region suggest that northern and southern Barents Sea populations should be considered separately for management purposes (Andersen et al. 2017), adding a new stock to this species assessment. Satellite tagging studies in the Pechora Sea in the period 2012-2017 provided evidence that walruses from the south-eastern Barents Sea extend into the Kara Sea (Semyonova et al. 2019). The examination of both broad-scale patterns in genetic structure and fine-scale patterns in relatedness of Pacific walrus suggests that the high spatiotemporal variation in the distribution of resources in the Pacific Arctic has favoured a gregarious social system, with unrelated animals forming temporary associations (Beatty et al. 2020).

Recent surveys and counts at haulouts (Hansen and Heide-Jørgensen 2018, Hansen et al. 2018a,b, MMC 2018, MOSJ 2019), reanalysis of older survey estimates (Semyonova et al. 2015, Hammill et al. 2016a,b, NAMMCO 2018), modelling studies (Hamill et al. 2016c, Taylor et al. 2017) and satellite tracking studies (Citta et al. 2018), as well as documentation of age structure (Greenland, Garde et al. 2018) have improved knowledge of walrus distribution, abundance and trends off Alaska, Canada and Greenland, Barents, Laptev and Chukchi seas since the SAMBR report. Although overall trends of abundance are missing for most populations, confirmed increasing trends have been documented for some Atlantic walrus stocks (North Water, Hansen and Heide-Jørgensen 2018; West Greenland-South east Baffin Islands, Heide-Jørgensen et al. 2018; Svalbard, MOSJ 2019). The Pacific walrus is a candidate to be listed as an endangered species under United States law, largely due to a dramatic decline in population numbers in recent decades and ongoing climate change-related concerns (Taylor et al. 2018). Taylor et al. (2018) suggest that the Pacific walrus population declined by 45% over the period 1985-2015. The rate of decline is thought to have slowed, though the probability that the population is still declining is between 45-87%, depending on model parameters. It must however be noted that there is considerable uncertainty in the number of Pacific walruses. A novel method using genetic mark-recapture estimates the population of Pacific Walrus to 283,213 individuals (CI: 93,000–478,975) in 2014 (Beatty et al 2017) vs the 2006 aerial survey conventional estimate of 129,000 (CI 55,000–507,000) (Speckman et al. 2011); the genetic estimate should be interpreted with caution due to its preliminary nature. Incomplete catch reporting and poorly documented struck and lost figures in Greenland and Canada hamper assessments (NAMMCO 2018). Despite this uncertainty, catches for walruses in all three stocks of Greenland, included the two shared with Canada, as well as those residing solely in Canadian waters are now to be considered sustainable (Matthews et al. 2018; GINR 2020). The CITES Scientific authority of Greenland evaluated the combined Greenland and Canada walrus catches from the Northern Baffin Bay population as unsustainable for the period 2013-2015 (GIR 2016), but thereafter, walrus catches in West Greenland have declined and were assessed as being sustainable for the period 2015-2020 (GINR 2016, 2017, 2020, NAMMCO 2018b).

Expanding non-renewable resource exploration and development in Baffin Island, Northern Greenland, the Barents and Pechora Seas, the Southwest Kara Sea, Bering Sea and Chukchi Sea are a concern for regional walrus populations (e.g., Semyonova et al. 2015, COSEWIC 2017, USFW 2017, USFW 2017, NAMMCO 2018). Dredging activities associated with mineral extraction or other forms of disruption of the sea floor associated with industrial exploration, construction or extraction is also a concern for this species because it disrupts the habitat of their primary prey (bivalves) (Todd et al. 2015). Disturbances at haul-out sites can cause stampedes, inducing high mortality rates, particularly in calves. Prolonged or repeated disturbances can cause walruses to abandon their haul out sites; this can affect the availability of the walrus to hunters (e.g., Huntington et al. 2017). Direct conflicts with fisheries are uncommon but development of trawl fisheries could be damaging to important benthic feeding areas (COSEWIC 2017, USFW 2017). Walruses feed most frequently low in the trophic web, so generally have relatively low levels of contaminants (e.g., COSEWIC 2017). However, in the Barents Sea contaminant burdens are high enough to represent a threat to walruses (Routti et al. 2019). Other assessments of their health remain normal both in terms of exposure to contaminant and UV (Martinez-Levasseur et al. 2016, Scotter et al. 2019) although disease risk for this gregarious pinniped is an increasing concern in a warming Arctic (Van Wormer et al. 2019). The greatest threat for walruses is climate change and its associated impacts on sea ice, which alter their habitat and expose them to increased anthropogenic activity and potential impacts of acidification on their prey (Kovacs et al. 2016, Udevitz et al. 2017, USFW 2017, Belikov 2018).

6. Ringed seal *Pusa hispida hispida*

Ringed seals are found throughout the circumpolar Arctic. Since SAMBR there have been no new stock assessments of ringed seal abundance anywhere in their range. Population assessments for ringed seals are challenging because they occupy snow lairs many months of the year and even when they are on the ice surface and accessible for aerial surveys (when they moult), they are small and occur at relatively low densities over large areas. Site-specific correction factors are required to account for animals in the water even under ideal survey conditions. In some areas ringed seals occupy vast offshore drift ice areas as well as shore-fast ice, making the required scale (and expense) of surveys large. Thus, few populations have current assessments and most ringed seal populations have never been assessed. Only part of the range of a single ringed seal population has trend information based on sequential abundance estimates; these surveys in southwestern Hudson Bay suggest that ringed seals are likely in decline in this region, although complex dynamics involving possible decadal cyclic variance overlaying long-term trends complicate analyses of both abundance and trends (Chambellant et al. 2012, Young et al. 2015); densities were highest in the first survey year (1995 - 1.22) and lowest in the most recent survey year (2013 - 0.20). Efforts are being made to combine the collection of high-altitude imagery with automated detection analysis in order to address this large data gap (Sigler et al. 2015, Young et al. 2015, 2019, Conn et al. 2016, Chernook et al. 2018, 2019, Yurkowski et al. 2018, Richards et al. 2019). Global warming, and concomitant sea ice losses are thought to be a serious threat to ringed seals (Kovacs et al. 2011, 2012). Modelling demographics for Amundsen Gulf and Prince Albert Sound suggested median declines in ringed seal population size (2017-2100) of between 50 and 99% (Reimer et al. 2019). Scientists in the United States, Canada and Norway (Kelly et al. 2010, COSEWIC 2019, Norwegian Red List – currently under revision) have all recently recommended that ringed seals be placed within "special concern" conservation categories because of their special breeding requirements (sufficient snow on relatively stable sea ice) and documented habitat losses. Nelson et al. (2019) assessed sustainability of Alaskan seal harvests and concluded that ringed seals harvests were within sustainable limits, although they note that hunt statistics were incomplete for some communities and that some stocks have not been surveyed recently (or ever) and that trend data are lacking (Muto et al. 2019). Assessments of the sustainability of harvests are lacking for all other regions in the ringed seal's range and harvests are high in some areas. Harvest statistics (or pelts sold) are available for Norway and Greenland (in that latter annual harvests were between 40,000-60,000 ringed seals annually from 2010-2019; NAMMCO catch statistics), but population abundance and trend data are not available to evaluate sustainability of the Norwegian or Greenlandic harvests, similar to many other regions.

Over the past 5 years, since Laidre et al. (2015) was published, considerable research effort into ringed seal biology and conservation status has been undertaken, in nearly all CBMP Arctic Marine Areas. The behaviour and ecology of this species varies quite dramatically across its vast range and regional studies are therefore essential for holistic assessments. For example, home ranges of ringed seals can range in size from a few kilometres to thousands of kilometres (Hamilton et al. 2015, 2016, Yurkowski et al. 2016). Research in the eastern Canadian Arctic has shown that seals living at the southern periphery of their geographic range are smaller, have higher reproductive rates and show greater inter- and intra-annual variation in body condition (Yurkowski et al. 2016, Ferguson et al. 2017,2018, 2019, 2020). These morphometric, behavioural and physiological patterns may afford ringed seals in this region some flexibility in dealing with global warming. Dietary shifts have been documented in the Beaufort Sea and in the Bering and Chukchi Sea (Boucher et al. 2020). In the western Canadian Arctic body condition and reproduction have shown recent declines, although core pupping habitat loss is predicted not to deteriorate before 2100 (Reimer et al. 2019, Harwood et al. 2020). But patterns of condition and reproduction in recent years vary markedly across their range, in the Pacific Arctic ringed seals are growing faster, maturing earlier and have thicker blubber in recent years compared to previous decades (Crawford et al 2015); there are also more pups in the harvest. However, in Svalbard where sea ice conditions have changed dramatically in recent decades, ringed seals appear to be retracting into small Arctic refugia areas and are not showing signs of flexibility with regard to habitat choices or dietary change (Hamilton et al. 2016, Bengtsson et al. 2020). They are diving more and resting less in both offshore and coastal habitats, suggesting that they are working harder to find food; offshore they are doing less sympagic diving and less area-restricted search as well (Hamilton et al. 2015, 2016, 2018a). Summer foraging migrations are now a lot longer compared to a decade ago, to reach preferred sea ice concentrations that have not changed (Lone et al. 2019). Ringed seals are showing some behavioural plasticity in responding to reduced sea ice conditions such as terrestrial haul-out by ringed seals being documented for the first time in areas where annual formation of sea ice has declined markedly (Lydersen et al. 2017). Similar patterns, with higher haul-out frequency in areas with sea ice cover have also been documented by Von Duyke et al. (2020) in the Pacific Arctic. Research has indicated spatial and temporal patterns in contaminants that generally show reduced contaminant burdens over recent decades in response to international bans on some toxic substances (Brown et al. 2016, Routti et al. 2016, Houde et al. 2017, 2019, Yurkowski et al. 2020). Although ringed seals are showing variable responses to ice reductions across their range, modelling demographics for some regions suggest quite alarming declines; Reimer et al. (2019) suggest median declines in ringed seal population size (2017-2100) of between 50 and 99% in the Amundsen Gulf and Prince Albert Sound regions this century.

7. Bearded seal *Erignathus barbatus*

Bearded seals have a broad circumpolar distribution, occupying shallow areas of the Arctic shelf seas. Since SAMBR several population estimates have become available as a result of a vast bilateral (Russian/American) survey effort focused on ice-breeding pinnipeds in the North Pacific Arctic and adjacent seas, undertaken in 2012 and 2013. The Eastern Bering Sea population is the largest reported for the species to date at 301,836

(CI 238,195-371,147), while the Western Bering Sea and populations in the Eastern and Western Chukchi seas range between circa 15,000-30,000 animals (Cameron et al. 2010, Conn et al. 2014, Chernook et al. 2018, 2019). No new surveys are available for the East Siberian Sea (or westward in Russia), the Beaufort Sea, the Arctic Archipelago or the Davis-Baffin-Hudson Bay regions. In the entire Atlantic Arctic region bearded seals have only been surveyed in southwestern Hudson Bay (covering only part of the regional stock's distributional area), in late spring 1995–1997, 1999–2000 and 2007–2008 and again in 2013. Densities in the surveys varied greatly across years (0.0036-0.0229 seals/km2, n = 7) with the highest estimates of density and abundance in the first survey year and the lowest in the most recent survey year (Chambellant et al. 2012). However, no statistically significant trend could be identified in these data. Expert opinion suggests that some 4,000-5,000 bearded seals occupy the White Sea (Svetochev and Svetocheva et al. 2012) and a population some 10x times this (40,000) live in the Kara Sea (Svetocheva et al. 2016), though no systematic surveys have been conducted in these areas. The lack of survey effort to monitor bearded seals is surprising given the significant hunting effort on this species in some areas. Nelson et al. (2019) assessed sustainability of Alaskan seal harvests and concluded that bearded seal harvests were within sustainable limits, although they note that hunt statistics were incomplete for some communities and that some stocks have not been surveyed recently (or ever) and that trend data are lacking (Muto et al. 2019). But assessments of the sustainability of harvests are lacking for all other regions in the bearded seal's range

Like other ice-associated pinnipeds, climate change is a threat to bearded seals (Kovacs et al. 2012, Lomac-MacNair et al. 2018). This species will haul-out on land when sea ice is not available but is dependent on sea ice for successful reproduction and generally shows a very strong affiliation with either drift ice (especially near edges) or near-shore floe ice (MacIntyre et al. 2015, Cameron et al. 2018, Hamilton et al. 2018b, 2019b, Kovacs 2018, Olnes et al. 2020). Bearded seals in Svalbard shifted their pupping substrate to glacier ice, when annual ice failed to form in west coast fjords in the mid-2000s (Kovacs et al. 2020b), but this alternate habitat is not likely to be a long-term solution in this region given that tide-water glaciers are melting and retracting onto shore. Bearded seal diets show variance with different ice concentrations in some areas (Hindell et al. 2012, Wang et al. 2016), with shifts between proportions of invertebrate vs fish occurring either through time or in direct association with sea ice concentration variation as well as varying with age class (Young et al. 2010). Increased risk of health-related problems with reduced sea ice is a serious concern for Arctic endemic seals, including bearded seals, that are unlikely to have immunity to many viruses, bacteria, parasites etc. that have not been part of their evolutionary history, but which are likely to become more prevalent in a warmer Arctic (Lefebvre et al. 2016, Foster et al. 2018, VanWormer et al. 2019). Traditional ecological knowledge holders in north and west Alaska suggest that bearded seals are already thinner and in poorer health (Huntington et al. 2017). They also report that the timing and pattern (distance from shore) of bearded seal migration has changed with reduced sea

Bearded seal. Photograph: Michael Cameron/Alaska Fisheries Science Center, NOAA Fisheries Service

ice (Huntington et al. 2017). However, in some regions bearded seals reach sexual maturity at a younger age and have thicker blubber than in the past, so patterns are not consistent across regions (Crawford et al. 2015). Bearded seals as a species might benefit somewhat from the extremely variable strategies individual animals employ in terms of movement patterns and foraging, with specialization at the individual level resulting in a generalist strategy at the species level (Hamilton et al. 2018b).

8. Harp Seals *Pagophilus groenlandicus*

Harp seals are pack-ice breeders that occur in the Arctic and subarctic waters of the North Atlantic. Populations are identified according to their pupping locations - in the Northwest Atlantic (pupping off Newfoundland and in the Gulf of St Lawrence), in the Greenland Sea (pupping off the east coast of Greenland near Jan Mayen) and in the White Sea (which is referred to as the White Sea/Barents Sea population because of their range). All three populations have been assessed recently (although new surveys are available for only two of the three stocks). A survey was carried out in the Greenland Sea in 2018. A total of 54,181 (95% CI: 36,078–72,284) pups were estimated to have been born (ICES 2019a). This estimate is significantly lower than estimates obtained in similar surveys in 2002, 2007, and 2012; with a 40% reduction from 2012 to 2018. The estimated population size was 426,800 (95% CI 313,000 – 540,600; ICES 2019a). Model fitting issues and uncertainty about the available reproductive data leave the trend for this population unknown (ICES 2019a). White Sea/Barents Sea harp seals have not been surveyed since 2013. However, abundance based upon the existing time series of pup production estimates, fecundity and removals suggest a population size of 1,497,000 (95% CI 1,293,000–1,701,000; ICES 2019a), which suggests a stable trend. The Northwest Atlantic population was assessed based upon pup production surveys carried out in 2017. Pup production was estimated to be 746,500 (95% CI 572,000 - 922,500) which is the lowest since 1994, although not significantly different from the previous survey in 2012, which estimated pup production at 815,900 (95% CI 679,700 - 952,100; Stenson et al. 2020b). The total population was estimated to be 7.6 million (95% CI 6.6 – 8.8 million) in 2019 (Hammill et al. 2020).

Reductions in sea ice associated with climate change are impacting all three harp seal populations. Recently there have been years with very high pup mortality because of low ice availability and higher variance in general in reproduction, pup survivorship etc. seem to be the new norm (Bajzak et al. 2011, Stenson and Hammill 2014, Hammill et al. 2015, 2020, Stenson et al. 2020c, 2020a). Shifts have occurred in the location of whelping locations in the Greenland Sea and in the Northwest Atlantic during years when ice conditions were extremely poor (Rosing-Asvid 2008, Stenson and Hammill 2014, Stenson et al. 2020c). When pupping occurs outside of the traditional areas, the young may be exposed to ice that is less stable and to different prey fields during the period when they are first learning to find food. In the Greenland Sea and areas off Newfoundland, increased predation from polar bears which travel great distances to seek out the pupping concentrations (Peacock et al. 2013) might become an issue. Other changes including shifts in abundance and distribution of many key prey species for harp seals has negatively impacted body condition and reproductive rates in White Sea/Barents Sea and in the Northwest Atlantic (Øigård et al. 2013, Stenson et al 2016, 2020b). Low levels of reproduction in the White Sea/Barents Sea may be due to increased pup mortality because of poor ice conditions in combination with competition for food with the large Atlantic cod stock (Stenson et al 2020a).

9. Hooded seals *Cystophora cristata*

Hooded seals are thought to be one panmictic population based on genetics (Coltman et al. 2007) but are surveyed and managed as two stocks (ICES 2019a). The Greenland Sea population pups off the east coast of Greenland north of the Jan Mayen while the Northwest Atlantic population pups in three locations with the largest group occurring off the coast of southern Labrador and northeast Newfoundland (the "Front"), and two smaller groups pupping in the Gulf of St Lawrence and in the Davis Strait. Since SAMBR, there are no new data on the abundance/trends of hooded seals in the Northwest Atlantic. The last survey was carried out in 2005 (Hammill and Stenson 2006). At that time the population was circa 600,000 animals and estimated to be increasing slowly. In the Greenland Sea population, the situation is quite different. This population has experienced a precipitous decline since the 1950s. The most recent survey of Greenland Sea hooded seals was conducted in 2018 (ICES 2019a). Pup production (12,977 CI= 9867–17067) estimated from this survey was lower than the surveys in 2005 and 2007, but similar to the survey conducted in 2012 (Øigård et al. 2014). Population models suggest that the population is either stable (at a new low level -circa 80,000) or is continuing to decline slowly, despite a ban on commercial hunting that was put in place in 2007 (ICES 2019a). Some of the hooded seal harvest in Southeast Greenland is very likely from this stock, which has been classified on the Norwegian Red List as Endangered (https://artsdatabanken.no/Rodliste). Hooded seals were also listed by the IUCN as being Vulnerable in 2016, based on the declines of this stock (https://www.iucnredlist.org/search?query=Cystophora%20cristata&searchType=species).

Climate change is a serious conservation concern for this ice-breeding species (Kovacs et al. 2011, 2012). Sea ice losses have occurred throughout the species' range over the last few decades (e.g., Stenson and Hamill 2014, Spreen et al. 2020). Reduction in ice cover in the Greenland Sea has resulted in smaller floes and less stable ice conditions that likely impact survivorship of pups. Additionally, pupping areas have shifted closer to the Greenland coast where hooded seals of all ages are more vulnerable to polar bear predation (Øigård et al. 2014). The occurrence of hooded seals has increased in the diet of both polar bears and killer whales in east Greenland (Foote et al. 2013, McKinney et al. 2013). Hooded seals from both stocks travel broadly outside the breeding season, covering much of the North Atlantic Arctic (Andersen et al. 2013, Vacquiè-Garcia et al. 2017b). Prey abundance and distribution in both the Greenland Sea and Northwest Atlantic are undergoing significant change that is very likely to impact hooded seals (e.g., Beaugrand et al. 2009, Christiansen 2017, Koen-Alonso and Cuff 2018, Buren et al. 2019, ICES 2019b, Pedersen et al. 2020). A recent dietary study on Greenland Sea hooded seals found that their diet is dominated by polar cod (***Boreogadus saida***), which is undergoing serious declines throughout the Barents region (Enoksen et al. 2017). Hooded seals also consumed krill and squid (***Gonatus fabricii***), but at lower levels than in the past. Some individuals ate some demersal fish such as sculpins and snailfish, likely as a result of their increased availability in recent years in shallow water areas. Despite the slight prey shifting, Enoksen et al. (2017) concluded that Greenland Sea hooded seals show narrow niche breadth and specialization on Arctic fishes that are suffering negative impacts of climate change.

10. Ribbon seal *Histriophoca fasciata*

Ribbon seals remain a poorly assessed FEC, in terms of abundance, trends and habitat use. Airborne, multi-spectral surveys with automated detection (Conn et al. 2014; Sigler et al. 2015; Conn et al. 2016; Chernook et al. 2018; Richards et al. 2019) have been applied to the sea-ice covered breeding range of ribbon seals in the Bering Sea, and comprehensive abundance estimates are being developed. Ancillary information about seasonal presence and distribution of ribbon seals around long-term, fixed arrays of moorings are also being collected by passive acoustic recording devices (Frouin-Mouy et al. 2019; Chou et al. 2020). These devices may soon become a practical means of detecting climate-related shifts in ribbon seals' (and other vocalizing seals') habitat use. Ribbon seals are harvested by Alaska Native subsistence hunters, though in much smaller numbers than bearded, ringed and spotted seals. Nelson et al. (2019) suggest that recent levels of subsistence harvest of ribbon seals are sustainable.

Ribbon seal health, especially as it relates to Arctic climate change, has been a focus of recent research (Lefebvre et al. 2016; Nymo et al. 2018; Goertz et al. 2019; Van Wormer et al. 2019), particularly in response to two unusual mortality events (UMEs). The first UME (Burek-Huntington et al. 2012; NOAA 2020a), which occurred from May 2011 to December 2016, involved all four species of North Pacific ice-associated seals (ribbon, spotted, bearded, and ringed). The primary symptoms were hair loss, delayed moulting, skin ulcers, lethargy, and laboured breathing, but after extensive testing, a definitive cause for the UME has not been determined. The second UME event took place in September 2019, but ribbon seals seemed to be rare or absent in the

Ribbon seal. Photograph: Michael Cameron/Alaska Fisheries Science Center, NOAA Fisheries Service

Spotted seal. Photograph: Jay Verho/Alaska Fisheries Science Center, NOAA Fisheries Service

strandings (NOAA Fisheries 2020b). However, ribbon seals are less coastal in their distribution at sea and may simply be underrepresented in the stranding statistics. The investigation of this UME is incomplete, but it appears to be different from the first, and more likely food related; most of the stranded seals have been young and/or emaciated. Although no clear link to climate-related changes has been established for the first UME, the co-occurrence of the second UME with record low sea ice extent and absence of ice from vast portions of the birthing and nursing areas in 2018 and 2019 for all four species of ice-associated seals in the Bering Sea is strongly suggestive of a major climate-related impact on these seal populations (Huntington et al. 2020).

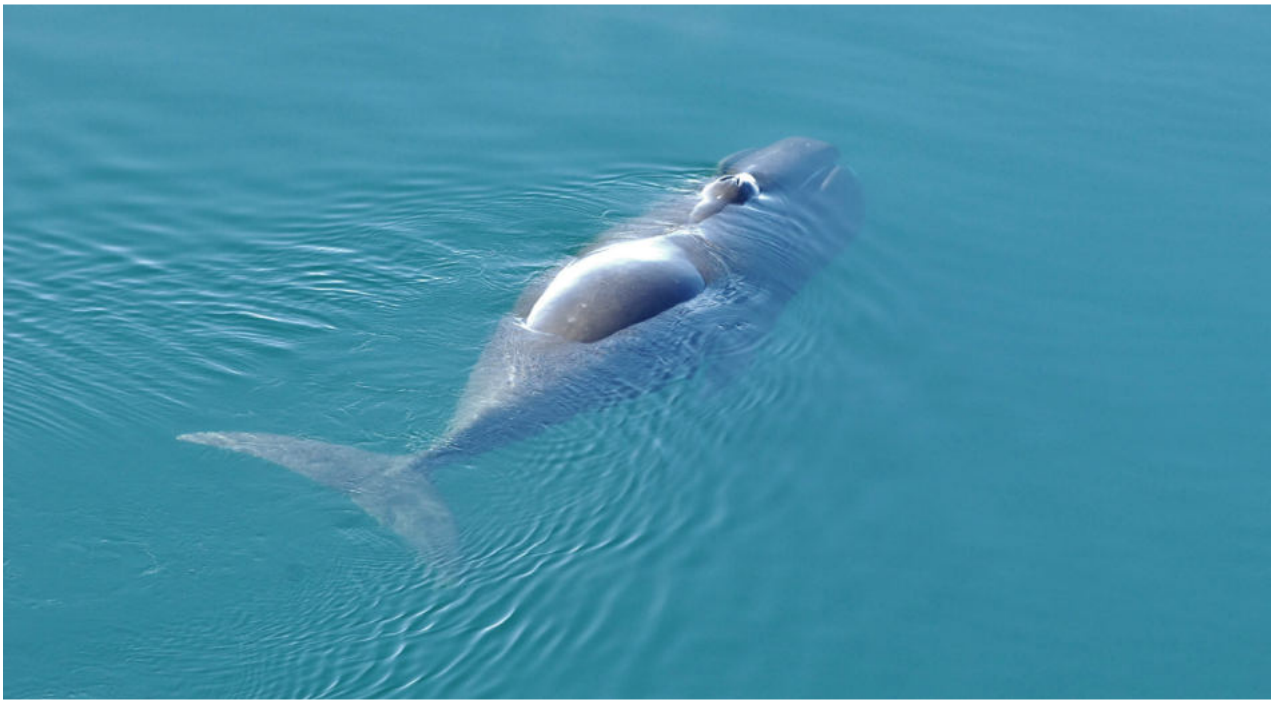
11. Spotted seal *Phoca largha*

Spotted seals are another poorly assessed FEC, in terms of abundance, trends, habitat use and harvest by indigenous communities. Airborne, multi-spectral surveys with automated detection (Conn et al. 2014; Sigler et al. 2015; Conn et al. 2016; Chernook et al. 2018; Richards et al. 2019) were flown in 2013 and 2014, encompassing vast areas of the sea-ice covered breeding range of spotted seals in the Bering Sea; comprehensive abundance estimates are being developed from these survey efforts. Spotted seals' habitat use has been studied via satellite tagging (see Citta et al. 2018). Nelson et al. (2019) suggest that recent levels of subsistence harvest of spotted seals by Alaska Native communities are sustainable.

Spotted seal health, especially as it relates to Arctic climate change, has been a focus of recent research (Lefebvre et al. 2016; Nymo et al. 2018; Goertz et al. 2019; Van Wormer et al. 2019), particularly in response to two unusual mortality events (UMEs). The first UME (Burek-Huntington et al. 2012; NOAA 2020a), which occurred from May 2011 to December 2016, involved all four species of North Pacific ice-associated seals (ribbon, spotted, bearded, and ringed). The primary symptoms were hair loss, delayed moulting, skin ulcers, lethargy, and laboured breathing, but after extensive testing, a definitive cause for the UME has not been determined. The second UME, for bearded, ringed, and spotted seals, was declared in September 2019, after large numbers of dead and stranded seals were found in the Bering and Chukchi Seas beginning in June 2018 (NOAA Fisheries 2020b). The investigation of this UME is incomplete, but it appears to be different from the first, and more likely food related; most of the stranded seals have been young and/or emaciated. Although no clear link to climate-related changes has been established for the first UME, the co-occurrence of the second UME with record low sea ice extent and absence of ice from vast portions of the birthing and nursing areas in 2018 and 2019 for spotted seals in the Bering Sea is strongly suggestive of a major climate-related impact to the population (Huntington et al. 2020).

KEY FINDINGS

- Insufficient (or non-existent) monitoring regionally or across taxonomic groups makes it impossible to present a holistic assessment of the status and trends of Arctic endemic mammals; trends for 66% of stocks are currently unknown.
- Direct and indirect impacts of climate warming continue to be the primary threat to Arctic endemic marine mammals, reducing their sea ice habitats and altering the ecosystems in which they live.
- Changes in distribution and phenology (such as timing of migration) of marine mammal stocks is making some stocks less accessible to hunters and reduced predictability of weather and sea ice conditions making hunts more challenging.
- Monitoring efforts should enhance collaboration with communities to improve knowledge of species health and population status.
- Arctic endemic marine mammals are being exposed to greater levels of threat from both anthropogenic impacts such as shipping and for some populations in the North Atlantic Arctic harvest levels are of concern; biotic changes that increase disease risks and possibly also the toxicity of contaminants are additional threats.
- At the same time endemic marine mammal populations are likely experiencing increased predation from open water predators and competition induced by range expansions of sub-arctic marine mammals.
- CBMP's ability to detect trends would improve considerably if:
  - Circumpolar monitoring plans were adopted by all CAFF range states for all Arctic endemic marine mammal species.
  - Specific recommendations from SAMBR regarding the nature of monitoring were acted upon (such as the fact that monitoring should include abundance and trends, reproductive parameters, selected parameters on health and body condition, passive acoustics, habitat change and telemetry tracking studies)
  - Collaborative harvest monitoring programs were established locally in Arctic communities to document all marine mammal harvests and to facilitate knowledge exchange regarding shifts in distribution, health, and age structure of populations in a timely fashion.
  - Assessments of Arctic endemic marine mammals considered cumulative effects of multiple stressors.



Bowhead whale. Photograph: Kit Kovacs and Christian Lydersen/Norwegian Polar Insititute

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Bowhead whale. Photograph: Vicki Beaver/Alaska Fisheries Science Center/NOAA Fisheries Service

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